Halictus latisignatus Cameron : a polymorphic Indian halictine bee with caste differentiation (Hymenoptera, Halictidae)[1]

BY

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(*With twenty-two text-figures*)

Recently we discovered an interesting cephalic polymorphism in the females of an Indian halictine bee, *Halictus latisignatus* Cameron, apparently linked with an incipient differentiation between queen and worker. The original description of this species being poorly given, Blüthgen (1931) made additional comments ; both sexes are re-described in the present paper. The biological data are still meagre. This paper gives the first biological data from the Oriental Region about halictine bees, which are remarkable for the occurrence of diverse types of social organization.

Description

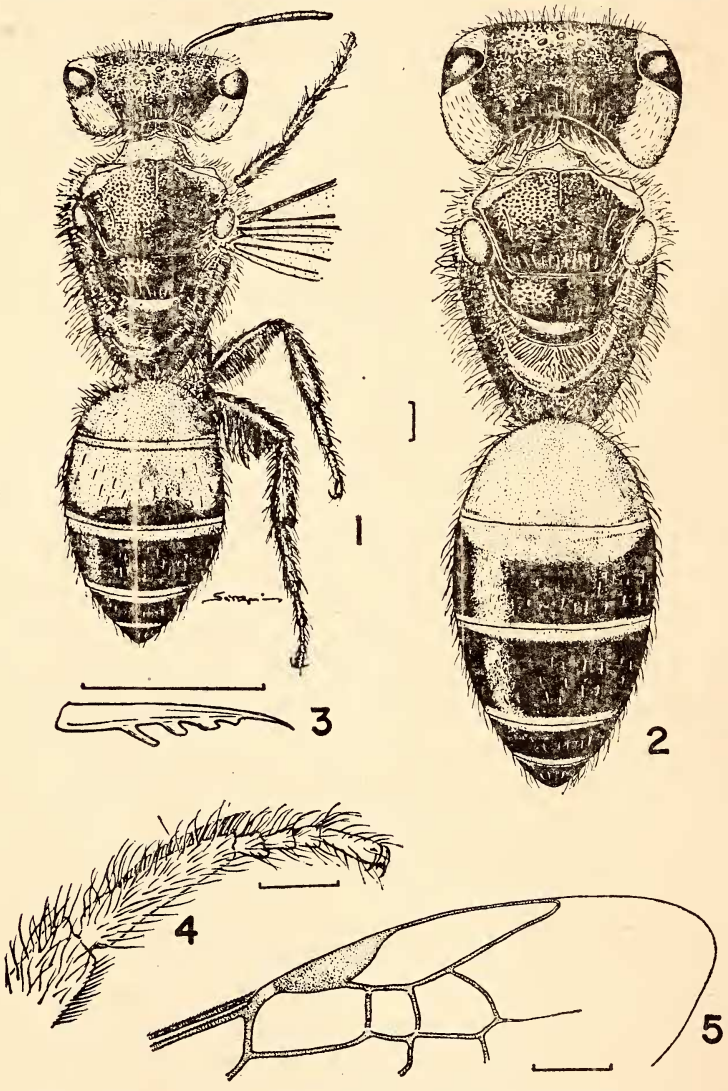
Halictus (Halictus) latisignatus Cameron

Cameron, 1908, *J. Bombay nat. Hist. Soc.* **18**:310; Blüthgen, 1931, *Zool. Jb. Syst.* **61** : 320, 324; Cockerell, 1937, *Amer. Mus. Nov.* No. 950 : 9.

SMALL FEMALE. Similar to *Apis florea* in size and blac-red colour pattern (Fig. 1). Metasomal marginal pubescence conspicuous. Head partly appears greyish because of dense appressed pubescence. Head swollen behind and above eyes. Body length 7-8·5 mm., length of forewing 5·5-6·5 mm.

[1] Contribution No. 686 from the Zoological Institute, Faculty of Science, Hokkaido University, Sapporo, Japan. In particular, the authors thank Dr. Ch. D. Michener, University of Kansas, for his kind suggestions.

Coloration. Black. Tergum I, T II basally, and sterna I-IV reddish brown, T III basally also reddish brown but often invisible. Antennal flagella tending to blackish brown, frontally often paler. Mandibles apically, tegulae, articulations of legs, coxae to femora below, and tarsal segments more or less brownish. Wings hyaline, veins pale brown to brown, veins *C* and *Rs* 3+4 darker, *Sc* and pterostigma dark brown.



Figs. 1-5. *Halictus latisignatus* Cameron : Females (All scales given, 0·5 mm.). 1 & 2. Small and Large Females; 3. Inner spur of left hind tibia; 4. Left fore tarsus; 5. Right forewing partly

Pilosity. Hairs white, those on sterna V-VI and hypopygium, tibiae, and tarsi mostly golden brown, those on black areas of terga darker,

Tempora, genae, and paraocular areas below with short appressed hairs, so dense and, especially on genae, tomentum-like that they completely cover surface. Supraclypeus, and face laterally, with similar but sparse and less appressed hairs. Vertex and face above medially rather sparsely haired, with sparse erect hairs intermixed on vertex. Clypeus with sparse but long stouter, downward-directed hairs. Eyes naked.

Pronotum above including posterior lobes, mesoscutum anteriorly, and metanotum anteriorly with dense tomentum-like hairs covering surface. Mesoscutum with sparse, rather erect hairs, slightly denser anteriorly, and with finer but denser, rather appressed hairs, denser laterally, both types sparser medially. Mesoscutellum and metanotum with erect hairs, longer than on mesonotum, especially posteriorly. Pleura with dense tomentum-like hairs, denser above and on metepisternum, and also with moderately dense longer hairs. Propodeum naked on horizontal area, with long erect hairs and relatively sparse, somewhat tomentum-like hairs on sides and on median area of declivity, on the former longer laterally. Posterior margin of forebasitarsi with differentiated, short but stout, dense hairs forming comb (Fig. 4). Legs otherwise normally haired.

Tergum I on anterior vertical area with sparse tomentum-like hairs and moderately dense, long, erect hairs, as on all terga laterally. T V with similar but denser and more appressed hairs. Marginal pubescence limited on T I to lateral corners, consisting of rather short and inconspicuous hairs; on T II fascia more conspicuous but still broadly interrupted medially; wider and complete on T III-IV. T II-IV basally with similar hair bands, though often concealed. Other areas of terga silky with dense, appressed hairs, so fine that T I-II appear nude medially seen from some directions, mixed with scattered stouter, longer, moderately appressed hairs of darker tint on T III-IV. Plumose hairs on sterna I-III medially fine but long.

Sculpture. Head (Fig. 20) with very dense, uniform, and small punctures, interspaces smooth and shining but seldom exceeding diameter of punctures even on vertex, so that surface appears as if dull coriaceous, especially on paraocular areas above, where punctation is densest. Area surrounding ocelli narrowly smooth and shining. Supraclypeus above similarly but more sparsely punctured, with interspaces irregularly sculptured, below more sparsely punctured, interspaces, larger than diameter of punctures. Clypeus above like supraclypeus, or punctures slightly sparser, below very sparsely and rather coarsely punctured, interspaces 2-3 times as large as diameter of punctures and smooth and shining. Hypostomata inconspicuously reticulate and shining, not striated, with scattered coarse and ill-defined punctures.

Mesoscutum uniformly punctured like head, more sparsely posteriorly where smooth shining interspaces are as large as diameter of punctures.

Mesoscutellum like mesoscutum but punctures sparser and interspaces larger than diameter of punctures. Metanotum finely and densely punctured, interspaces irregular, giving reticulo-coriaceous appearance. Pleura striated; interspaces coriaceous and dully shining. Propodeal enclosure with distinct transverse or oblique striation, varying in individuals, interspaces coriaceous and dully shining; medially striation a little irregular. Other parts of propodeum very finely punctured, appearing coriaceous except latero-anterior parts, which are striated like pleura.

Terga with very fine but distinct punctures, dense and uniform, as fine, but not so dense, as on face; though interspaces less than diameters of punctures.

Structure. Head (Figs. 1, 20, 21) about as wide as, or slightly wider than, distance between outer margins of tegulae. Seen dorsally, distinctly extending behind eyes, with roundly and gently convergent lateral contour; distinctly curved post-marginally; occiput not carinate. Seen oblique-dorsally, ocellocular distance slightly less than ocelloccipital distance, than twice the interocellar distance, and than four times the diameter of anterior ocellus (80 : 90 : 55 : 22). Seen frontally, approximately as long as wide, with round-cubic contour, upper margin gently convex. Supraorbital line passing through middle of anterior ocellus. Upper third of inner orbits slightly divergent below, remainder nearly parallel. Ratios of eye length to upper, middle, and lower interorbital distances about as 22 : 23 : 25 : 24·5. Vertex and frons medially gently raised, frontal line not keeled. Supraclypeus gently convex above, lateral margins slightly convex. Clypeus transverse and flat; upper margin laterally gently concave, without specific emargination; lower interorbital line passing at or slightly above middle of clypeus; lower margin of clypeus transverse, slightly pointed at lateral angles, medially with blunt rounded process. Seen laterally, genae distinctly enlarged, about 1·5 times as wide as maximum eye width seen laterally, not angulate below. Hypostoma flat and simple. Labrum normally bituberculate. Mandibles stout, bidentate. Scape a trifle longer than ocellalveolar distance (14 : 12), apex not exceeding posterior ocelli, about half as long as pedicel and flagellum combined. Pedicel knot-like, distinctly longer than wide (25 : 20). Seen frontally, flagellum I distinctly longer than F II, slightly longer than F III, slightly shorter than F IV, and longer than apical width (25 : 20 : 23 : 27 : 23).

Pronotum laterally not strongly projected anteriorly: anterior margin approximately straight, ending in distinct lateral angulation; lateral margin gently concave. Mesoscutum anteromedially slightly bilobed, with differentiated shining vertical area separated from rest by distinct carina. Mesoscutellum gently convex, without median furrow, distinctly longer than metanotum and nearly as long as horizontal area of propodeum. Horizontal area of propodeum posteriorly not carinate;

separated from vertical declivity by rounded angle; posterior margin of horizontal area gently curved, not triangular nor squared; enclosure demarcated by fine suture. Posterior declivity with lateral carinae only in lower half.

Legs normal, inner hind tibial spur (Fig. 3) with four (occasionally five) spines. Three basal spines slender, round-headed; apical one knot-like. Hind basitibial plate normal. Ratios of hind tibia to hind basitarsus and to other tarsal segments combined 26 : 18 : 14. Radial cell about 4 times as long as wide (22 : 5·5), apex rounded, not on wing margin. Pterostigma slightly shorter than three times its width (12 : 3·5). Submarginal cell I slightly shorter than II+III (11 : 4·5 :8), Cell II receiving 1 m-cu subapically, and III receiving 2 m-cu at apical $\frac{1}{3}$. Veins 1 and 2 r-m not weakened. Hamuli usually 8, occasionally 9 (Fig. 5).

Metasoma elongate oval. Tergum I not elongate. T II and III basally distinctly depressed. Submarginal lateral convexities mild, marginal areas only slightly depressed, not particularly depigmented.

LARGE FEMALE (Figs. 2, 18, 19). Like small female but distinctly larger (body length 11 to 15 mm., length of forewing 7·5-9 mm.), and conspicuously macrocephalic. Seen dorsally, head distinctly wider than distance between outer margins of tegulae, behind eyes distinctly projecting posteriorly, posterior margin semicircular. Seen oblique-dorsally, ocelloccipital distance distinctly longer. Seen frontally, head distinctly cubic, greatly enlarged above eyes. Upper margin straight or occasionally even gently concave. Inner orbits distinctly divergent below. Clypeus distinctly wider. Scape distinctly surpassing postocellar line. Seen laterally, genae enormously developed. Hypostoma with strong triangular process. Mandibles stouter. Punctation on head distinctly sparser, especially on paraocular areas and vertex, where interspaces are often 2 or even 3 times as large as diameter of punctures, correspondingly smoother and more shining in general appearance. Smooth area surrounding ocelli very conspicuous. Punctation of mesoscutum and mesoscutellum also slightly sparser, though not so conspicuously so as on head. Hamuli 9-10.

MALE. Similar to female in general appearance. No pale markings on legs and head. Antennae reaching middle of mesosoma. Metasoma not particularly slender nor curved. Terga weakly convex. Body length 7·5-9 mm., length of forewing 6-7 mm.

Pilosity. Differing from female: (1) White hairs often having slight tint of yellow ochre, particularly on lower paraocular areas along inner orbits; (2) Tomental hairs far less developed on paraocular areas below, genae, pronotum above, and mesoscutellum changing to mere slightly dense undergrowth, not completely covering surface except on limited parts of lower paraocular areas and pronotum: mesoscutum and tergum

I practically without appressed hairs; (3) Clypeus more sparsely haired: hairs on paraocular areas above dense but sparser than in female, rather erect; (4) tergal marginal pubescence less developed, reduced to inconspicuous side patches on T I, still uninterrupted but narrower on T II-IV, often not completely covering surface.

Legs as in males of *Halictus* s. str., but foretarsi with long posterior hairs, nearly 3 times as long as width of segment (Fig. 7), postmarginal hairs of forefemora moderately developed, as long as width of segment, but not so long as in many species of *Lasioglossum*. Sterna I-III with fine, dense golden-tinted hairs, postmarginally denser and more whitish, forming inconspicuous bands. Sterna IV-VI with stouter, darker, and denser hairs, showing differentiation as described below.

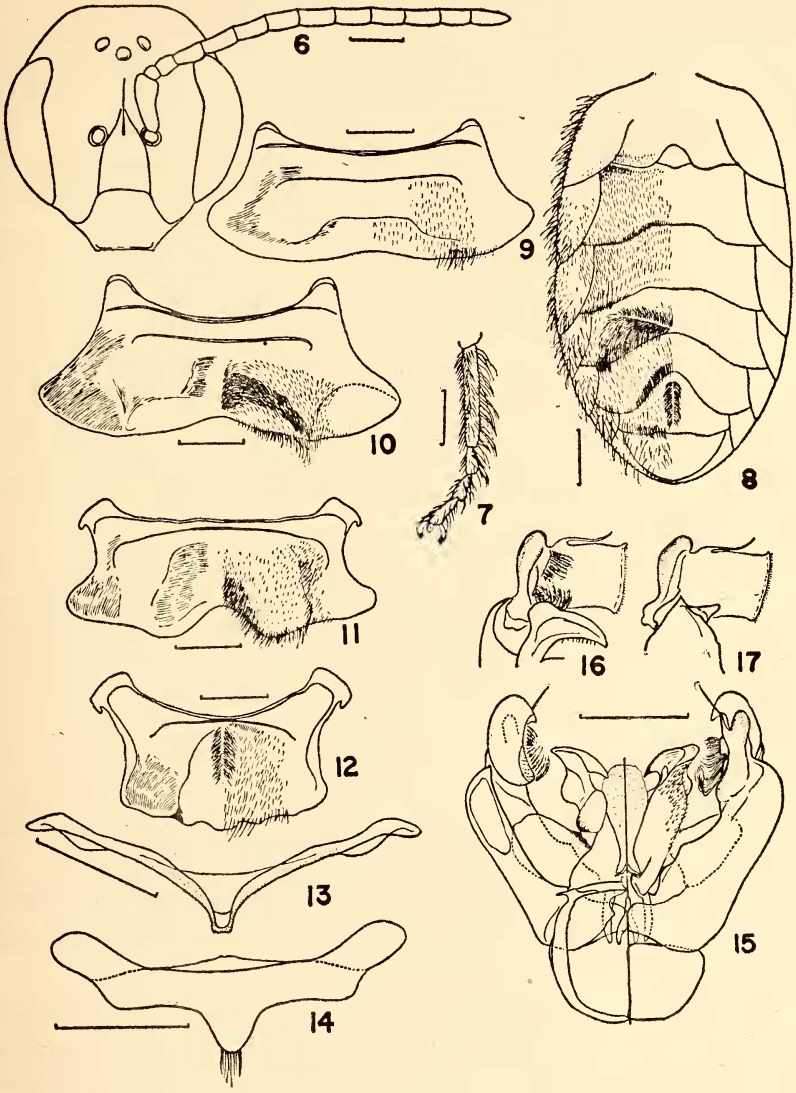
Sculpture. As in female but generally coarser, especially on mesoscutum, mesoscutellum, and T I anteriorly. Striation on propodeal enclosure also a little coarser.

Structure. General structure as in female. Head (Fig. 6) slightly narrower than distance between outer margins of tegulae (35 : 37), slightly longer than wide (40 : 38), not so conspicuously swollen as in female. Ratios of ocellocular, ocelloccipital, interocellar distances, and diameter of anterior ocellus, 8 : 9 : 6 : 3. Outer orbits more convex, inner orbits more convergent below. Ratios of eye length to upper, middle, and lower interorbital distances 24 : 24·5 : 26 : 23. Clypeus projecting below, lower orbital line distinctly above its middle, lower margin straight and simple. Scape about $\frac{1}{6}$th as long as pedicel and flagellum combined. Pedicel slightly longer than double the width. Ratios of lengths of flagellum I-IV and width of F I and IV, 35 : 50 : 54 : 55 : 36 : 28. Flagellum I distinctly convex below basally, apical flagellamere slightly over twice as long as broad, gently concave above and convex below.

Basal depressions and submarginal convexities of terga mild, corresponding to those in *Halictus tumulorum*. Marginal areas very weakly depressed, without anterior demarcation. Tergum VII apically rounded, medially narrowly smooth and shining; ventral flexion narrow, not separated by ridge from dorsal part, Sterna II-III (Figs. 8-9) posteriorly gently concave. S IV posteriorly more concave, medially with dense, stout hairs radiately arranged (Fig. 10). S V (Fig. 11) posteriorly with deep semicircular emargination, marginal hairs simpler than on S IV, longer medially. S VI (Fig. 12) posteriorly irregularly lobed, marginal hairs simple but anterior half of postgradular area with dense paired longitudinal hair tufts, consisting of stout hairs directed obliqueposteriorly. S VII (Fig. 13) slender, median projection narrow but conspicuous, truncate apically. S VIII (Fig. 14) posteriorly straight with distinct round-headed triangular projection medially, with conspicuous hair tuft.

Genitalia (Fig. 15) resemble those of *H. tumulorum*. Gonobase

between $\frac{1}{3}$ and $\frac{1}{2}$ as long as gonocoxite, anterior dorsal margin rather straight, ventrapical dechitinized window elongate and conspicuous.



Figs. 6-17. *Halictus latisignatus* Cameron : Males (All scales given, 0·5 mm.). 6. Head seen frontally ; 7. Left foretarsus; 8. Ventral side of metasoma ; 9-14. Metasomal sterna III-VIII ; 15. Genitalia (left ventral, right dorsal view) ; 16. Lateral inner view of left gonostylus ; 17. Lateral outer view of right gonostylus

Gonostyli (Fig. 15, 16) issuing from inner sides of apices of gonocoxites, not petiolate ; dorsally projection with round apex ; ventral lobe broad and quadrate, inner hair tufts conspicuous, consisting of curled plumose hairs, basodorsally with conspicuous flagellar process, apex of which does not exceed apical margin of ventral lobe, apical margin of ventral lobe truncate and broad, with very fine setae ; basal external projection

simple and small. Penis valves not extending much beyond gonocoxites, dorsally simple with conspicuous, dense, bristle-like hairs.

DISTRIBUTION. Previous records : Deesa and Matheran, India.

Specimens examined. Lonavla, Western Ghats, India (650 m.): many specimens as given later; Sinhagad, W. Ghats, India (1320 m.): 2 small females, 7 Jan. 1964. All collected by F. L. Wain.

VARIABILITY. The coloration of female tergum II is variable. In the most melanic individuals (Fig. 2), only the basal third is reddish at the middle and the black area reaches to the base laterally. In the opposite extreme (Fig. 1), only apical third or fourth is black, with or without lateral extension, and the tint becomes very pale. In more than half of specimens examined (18/30), however, the black area occupies the apical $\frac{2}{3}$ of the sclerite and extends forward laterally but not to the base. The male shows similar but wider variation, but only six specimens were examined. In the melanic extreme, T II is completely black, leaving a dim transverse trace of reddish at the base medially. In the opposite case, the whole sclerite is reddish with a similar dim, slightly darker band apico-medially.

The antennae are nearly black with a slight brownish tint anteriorly in the melanic extreme; dark brown, anteriorly paler, the apical segments anteriorly yellowish brown in paler specimens. The mandibles vary from only apically reddish brown to cases in which the apical $\frac{2}{3}$ and basal articulations are reddish brown, and tegulae from nearly yellowish to dark brownish. Similar variation is also seen in the legs.

Striation of the propodeal enclosure varies among individuals. In some individuals several transverse striae run parallel to the anterior margin of the sclerite before the oblique striation (Fig. 1). In an extreme case the latter was nearly absent. In other individuals, such transverse striation is reduced and the oblique striations start directly from the anterior margin (Fig. 2). The median portion of the enclosure also varies as to degree of irregularity in sculpture.

AFFINITY. The specimens examined agree with the original description by Cameron, including wing venation and the presence of metasomal anal rima. The specimens also agree with the comments of Blüthgen (1931). This clearly shows that they belong to *H. tetrazonius* group (=*Halictus* s. str. in the sense of Michener 1944), though the male apical sterna have a peculiar arrangement of hairs.

Compared with typical species of *Halictus* s. str. (and also of the subgenus *Seladonia*), this species is peculiar in the possession of long hairs on male foretarsi. The anteriorly carinate mesoscutum and differentiated comb-like hairs on the female foretarsi are also remarkable, but both are found in lesser degrees in some other species of *Halictus* s. str. For instance, *H. quadricinctus* (Fabricius) approaches *latisignatus*

in both, especially in the latter character. The differentiation of male sterna V and VI, especially the latter, gives good distinctive characters. As to the male genitalia, the relatively large gonobase with straight dorsal anterior margin, and the non-petiolate gonostyli rather resemble those of *H.* (*Seladonia*) *tumulorum* than those of some species of *Halictus* s. str. At any rate, there is no reason to consider this species other than an Oriental offshoot of *Halictus* s. str., a primarily Holarctic group.

This species further resembles *Halictus acrocephalus* Blüthgen (1926) from Pusa (Bihar), India. He did not discuss this similarity in his paper in 1931, but the species runs straight to *H. acrocephalus* in his key of ' more or less reddish coloured (Oriental) species ' (1926, p. 604) by

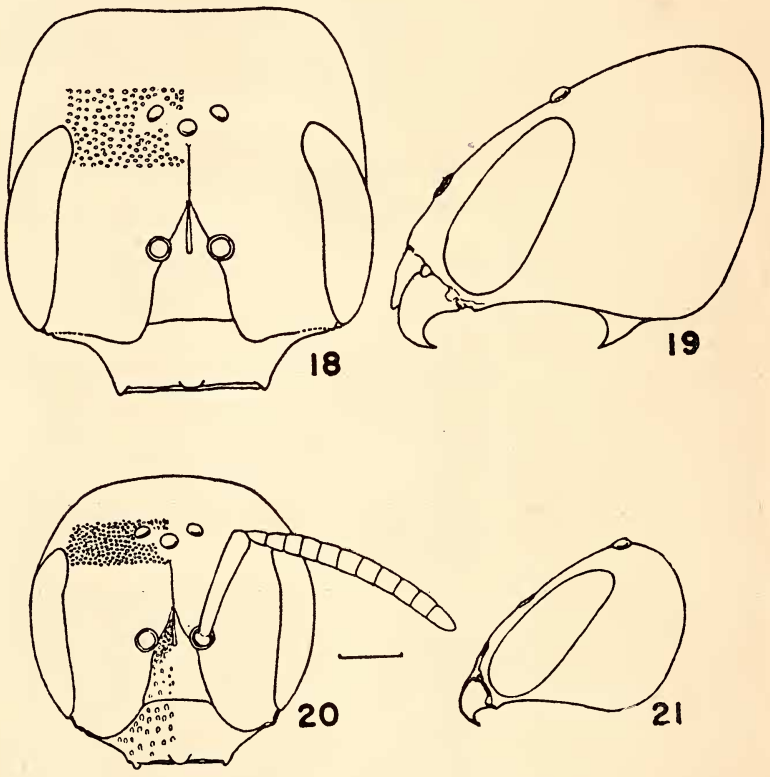
TABLE 1

DIFFERENCES BETWEEN *Halictus acrocephalus* AND *H. latisignatus*

	acrocephalus	*latisignatus* (small female)
1. Body size	5-5·5 mm.	7-8·5 mm.
2. Dark metasomal area	Schwarzbraun [Blackish brown]	Black
3. Coloration on tergum I	Gewölbte Mittelpartie und Beulengegend geschwärzt [Convex centre and lateral elevation black]	Totally reddish
4. Tergal marginal area	Durchsichtig horngelb [Transparent horny-yellow]	Not particularly depigmented
5. Supraclypeus and clypeus	Wie Stirn, aber viel flacher und deshalb ganz obsolet punktiert, Kopfschild unten etwas stärker (aber auch noch äusserst feiner) punktiert [As the vertex, but much smoother, and therefore with the punctures quite obsolescent, clypeus below somewhat strongly (but extremely finely) punctured]	Distinctly and rather coarsely punctured
6. Sculpture of propodeal enclosure	Mikroskopisch feiner, äusserst dichter welliger Längsrunzelung [Microscopically fine, extremely close, wavy, longitudinal lines]	With distinct transverse or oblique striation
7. Tergal sculpture	Mit netzartiger Chagrinierung, . . . ohne Punktierung [With reticulate sculpture, . . . without punctation]	Finely but distinctly punctured

the possession of tergal pubescence and enlarged head. Further, the two species agree in the colour pattern and presence and distribution of white tomentum-like hairs on the head and mesosoma. But they may easily be distinguished by the characters shown in Table 1.

FEMALE POLYMORPHISM. As indicated in the description, the females show a conspicuous polymorphism due to cephalic allometry



Figs. 18-21. *Halictus latisignatus* Cameron: Cephalic polymorphism in females (Scale given, 0·5 mm.). 18-19. Large female; 20-21. Small female. Both, from front and in profile

(Figs. 18-21). To show this clearly, the measurements of various head parts of one small and one large female were converted into ratios to mesosomal width (=distance between outer margins of tegulae, 2·06 mm. in the small female and 2·75 mm. in the large one) and the relative values of the larger female were divided by the corresponding values of the small female. The results are shown in Table 2.

TABLE 2

COMPARATIVE TABLE OF MEASUREMENTS OF FEMALES OF *Halictus latisignatus*

Part measured	Ratio of part measured to mesosomal width		Ratio large ♀/small ♀
	small ♀	large ♀	
Eye length ..	0·62	0·60	0·96
Eye width (seen laterally) ..	0·24	0·23	0·96
Head length ..	1·04	1·06	1·02
Scape length ..	0·41	0·49	1·02
Upper interorbital distance ..	0·68	0·77	1·07
Interocellar distance ..	0·15	0·16	1·07
Middle interorbital distance ..	0·78	0·84	1·12
Head width ..	1·02	1·14	1·12
Ocellocular distance ..	0·24	0·27	1·12
Ocellalveolar distance ..	0·34	0·42	1·23
Alveorbital distance ..	0·25	0·31	1·24
Lower interorbital distance ..	0·72	0·91	1·26
Genal width ..	0·38	0·56	1·48
Ocelloccipital distance ..	0·26	0·44	1·69

Obviously, the values may vary a little when a large number of individuals are measured. But the increase of the ratios shows the relative increase in measurements of the large female from the frons upward, posteriorly, and downward. The same tendency is more or less seen in other species with similar macrocephaly (Quénu 1957 ; Sakagami & Fukushima 1961 ; Sakagami & Moure, in press, a).

To show the relation between the macrocephalic tendency and absolute body size, two ratios were chosen: head width/mesosomal width and genal width/eye width. In Fig. 22, these ratios were plotted against the absolute values of head width and lateral eye width respectively. The results clearly show that both head and genal widths allometrically increase with the increase in absolute size, as is known in other species. But the macrocephalic tendency in this species is stronger than in most other cases so far known. Here, one of us (S.F.S.) would

like to repeat a warning against the uncritical application of craniometry to distinguish species in halictine bees.

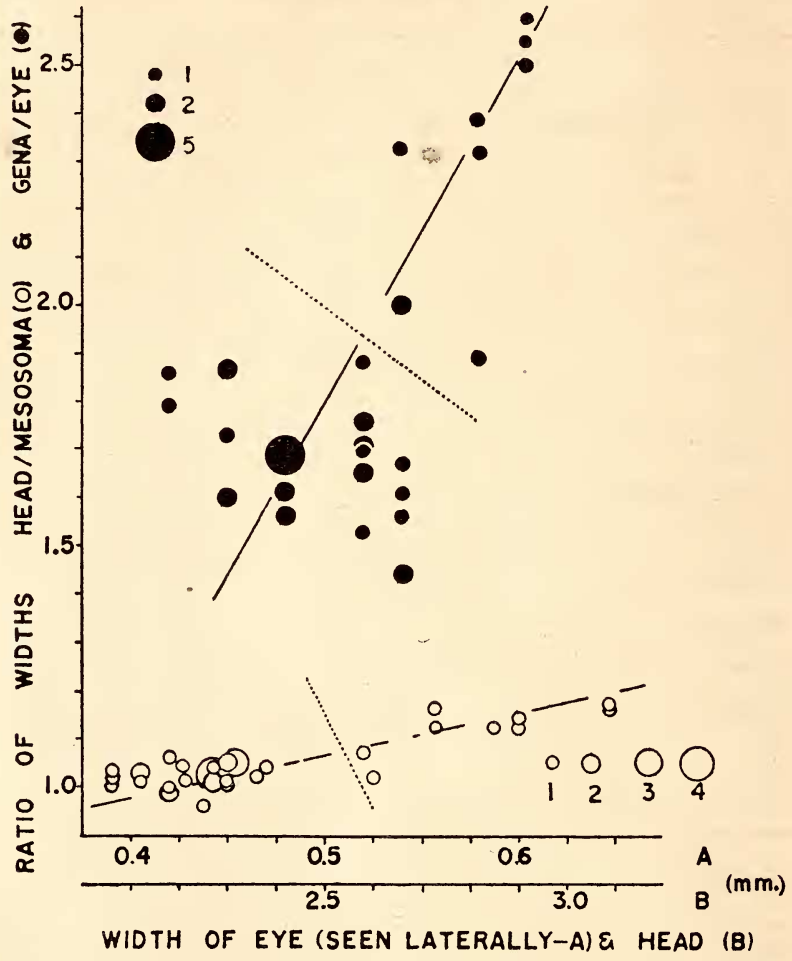


Fig. 22. *Halictus latisignatus* Cameron : Relation between body size and ratios Genal width/Lateral eye width and Head width/Mesosomal width in females. Regression lines are made by eye. Dotted lines indicate approximate division between queen and worker.

As indicated in the description, at least three non-metric characteristics vary in a fashion parallel with the macrocephaly : increased number of hamuli, appearance of the genal process, and decreased density of punctures on the head. The increase of hamuli parallel to the increased body size is known in many other social Hymenoptera (bumble bees, stingless bees, cf. Schwarz 1948) both intra- and interspecifically, and even in cases of isometric body increase. Hence this tendency may be regarded as a general trend in the bees, not specially linked with the

cephalic polymorphism. The appearance of genal processes in large females is known in *Megalopta genalis* Meade-Waldo, a Neotropical nocturnal halictine bee. Michener (1954) regarded *M. fornix* var. *panamensis* Cockerell, a smaller form with normal head and without genal processes, as conspecific with *M. genalis*, the type of which is unusually macrocephalic with strong genal processes (cf. also Sakagami & Moure, unpub.). Apparently *H. latisignatus* shows a parallel variation. It is possible that such genal processes may become fixed specifically, as seen in *H.* (*H.*) *ligatus* Say. In such instances this character may be used as a diagnostic one. Yet it is better not to over-emphasise its value. Recently one of us (S.F.S.) found in a nest of *Megalopta* sp., one female with a normal head while another, a slightly macrocephalic one, had a genal process on one side but not on the opposite side (Sakagami & Moure in press, b).

Decreased density of punctures parallel to increased head size has so far been ignored. One of us (S.F.S.) examined three halictine species, all showing conspicuous cephalic polymorphism: *H.* (*H.*) *scabiosae* (Rossi), *Augochlora semiramis* Schrottky, and *H.* (*Seladonia*) *hesperus* (Smith). This tendency was not found in the first two species, but was in the last, though not so conspicuously as in *H. latisignatus*.

CASTE DIFFERENTIATION. It is known at least in two species with cephalic polymorphism, *H. scabiosae* in Europe (Quénu 1957) and *H.* (*Seladonia*) *aerarius* (Smith) in Japan (Sakagami & Fukushima 1961), that this phenomenon relates to caste differentiation: the large macrocephalic females are queens, the small, microcephalic ones, workers. Considering this fact, some specimens of *H. latisignatus* (all collected on flowers in Lonavla during October 1964 by F.L.W.) were preserved in fixative and the internal features were examined. The results are shown in Table 3.

The relative age was determined by the wear of mandibles and wing margins. Parentheses in the last column indicate a degenerated state. The specimens examined are few in number, and we have not yet had a chance to discover the nest of this species. Nevertheless, the results clearly indicate the occurrence of queen-worker differentiation. A glance at the table shows that all females with head width less than 2·50 mm. (Nos. 1-11) are unfertilized. They are all fully laden with pollen, suggesting active foraging on flowers. Based upon the recent advance in halictine biology, it is impossible to regard them as caring solitarily for their own broods. Their ovaries are mostly undeveloped. Besides the specimens in the table, six small females taken on flowers were examined by F.L.W. as to ovaries but not spermathecae; four of them had undeveloped ovaries, two slightly developed ones. The occasional development of ovaries in workers of queen-right nests of some social

halictine bees is not rare. Therefore, it is certain that these small females were acting as workers.

TABLE 3

INTERNAL FEATURES OF FEMALES (QUEENS AND WORKERS) OF *Halictus latisignatus*

Serial No.	Date of collection	Head width (in mm.)	Age	Pollen loads	Fertilized or not	Ovary development
1	Oct. 20	2·27	old	+	–	(±)
2	18	do.	mid.	+	–	–
3	do.	do.	do.	+	–	–
4	20	2·30	do.	+	–	±
5	do.	do.	old	+	–	–
6	do.	do.	do.	+	–	±
7	26	do.	young	+	–	–
8	18	do.	do.	+	–	–
9	20	2·36	old	+	–	–
10	26	2·38	mid.	+	–	–
11	20	do.	do.	+	–	–
12	26	2·58	young	–	+	–
13	20	2·60	old?	±	+	(±)
14	do.	2·73	young	–	?	±
15	26	2·85	do.	–	+	–
16	20	2·90	mid.	±	+	++
17	do.	do.	old?	±	+	–
18	do.	3·09	do.	–	+	(±)
19	do.	do.	do.	–	+	(±)

On the other hand, all large females except one, the examination of whose spermatheca was unsuccessful, are fertilized. They carry either poor pollen loads or none. The ovaries are mostly still rudimentary or poorly developed or already degenerated. Probably this indicates that these large females collected on flowers were either young individuals before or immediately after starting nests, or those which were quite old and had abandoned the nests. It seems likely that the large females or queens at the peak of reproductive activity usually remain in their nests, so that they are rarely collected on flowers. It is interesting, however,

that one large female with very well-developed ovaries was collected (No. 16 in the table). This may have been from a solitary nest of relatively advanced stage before the production of workers, or may have been taken on the occasional flight of the queen at the peak of reproductive activity (this is occasionally found in the summer matrifilial nest of *Lasioglossum duplex* Dalla Torre, Sakagami, unpub.). Only this individual was middle aged among the large females, and her ovaries were enormously developed, not comparable with the slightly developed ovaries of some small bees (Nos. 1,4,6 in the table). This difference is comparable to that found between queens and workers with developed ovaries in some social species, for instance *Lasioglossum* (*Chloralictus*) *inconspicuum* (Smith) (Michener & Wille 1961).

Therefore, it is clear that the differentiation between queen and worker does exist in this species, though the type of social organization is still not well known.

PHENOLOGY AND FLOWER VISITS. Specimens examined were mostly collected in Lonavla, in the Western Ghats, situated on the Deccan side, 650 m. in altitude, about 65 km. from Poona. It is situated on the edge of the thick monsoon forest which covers the Ghats, and small patches of forest remain here and there at Lonavla. The whole area is basalt with scattered beds of clay. Three seasons can be distinguished in the district: Cold (approximately November-February, air temperature averaging 14-25°C.); Hot (March-May, 23-34°C.), and Rains (June-October, 20-26°C.). The specimens collected in Lonavla are arranged in Table 3 according to this seasonal cycle as follows, each month being divided into three 10-day periods. The relative age was determined by the wear of mandibles and wing margins. The results are shown in Table 4. The collecting was not done quantitatively and the number of specimens is still scanty. But except for the rainy season and December, the collecting covers all months and the distribution shown in the table surely reflects a seasonal shift. The absence of any activities during the rains is definite. During this season the rain is very heavy and almost incessant; almost the whole of the annual rainfall, averaging 4000 mm. or more, occurs during this time. There are few flowers and practically no activity of bees of any kind was seen on occasional visits there. Except for this season, the activities of *H. latisignatus* appear to be continuous (no collecting was done in December), but the peaks of abundance are apparently in May and October, that is the periods before and after the rainy season, and males and large females seem to appear only in these periods. At these times, weather conditions are most favourable, flowers are abundant, and many other species of bees flourish. In contrast to the species in temperate regions, there is no definite seasonal shift in age or caste. Both young

and old workers are captured side by side. Probably nests of diverse stages may occur at the same time, this being characteristic of many tropical species.

TABLE 4

SEASON OF COLLECTION AND AGE OF SPECIMENS OF *Halictus latisignatus* COLLECTED AT LONAVLA

Season	COLD		HOT			RAINS			COLD	
Month	I	II	III	IV	V	VI	VII-IX	X	XI	XII
Males	. . .	. . .	. . .	122	.41	5 . .		. . 1	. . .	. . .
Small females										
young	1 . 3	. . .	. . 2	21 .	28.	. . .		11.	. . 2	. . .
middle	1 . 1	11.	. . 1	1 . 1	14.	. . .		222	1 . 4	. . .
old	3 . 2	2 . .	. . .	3 . 1	. 1 .	. . .		. . 4	2 . .	. . .
Large females										
young	. . .	. . .	. . .	. . .	1 . .	. . .		221	. . .	. . .
middle	. . .	. . .	. . .	. . .	. . .	. . .		. . 2	. . .	. . .
old	. . .	. . .	. . .	. . .	. . .	. . .		. . 4	. . .	. . .

Flower visits have not been systematically observed. There are the following records: *Erioloena candollei* (Sterculiaceae), *Zizyphus* sp. (Rhacmneae), *Leea sambucina* (Ampelidaceae), *Terminalia* sp. (Combretaceae), *Cyathocline lutea*, *Senecio grahami* (Compositae), *Pogostemon purpurascens*, *Dysophyla stellata* (Labiatae), *Celosia argentea* (Amaranthaceae).

SUMMARY

Both sexes of *Halictus* (*Halictus*) *latisignatus* Cameron are re-described. The females of this species have conspicuous cephalic polymorphism. Large females are decidedly macrocephalic, with some associated morphological differentiation. Anatomical examination confirmed that this polymorphism relates to caste differentiation: large females are queens and small females are workers. The phenology and flower associations are briefly treated.

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